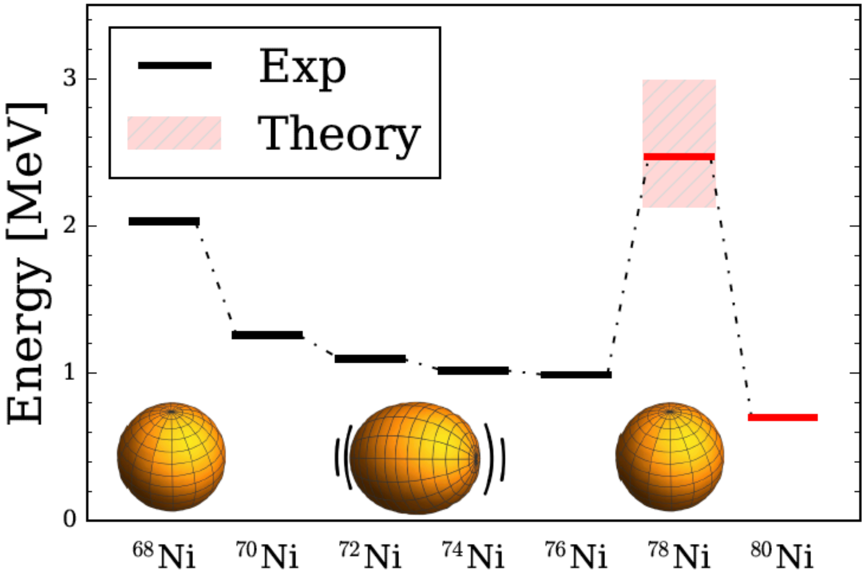
Computing the structure of the rare nucleus ^{78}Ni

Objectives

- Determine the structure of the supposedly doubly magic nucleus ^{78}Ni, consisting of 28 protons and 50 neutrons.
- Compute the 2_1^+ state in ^{78}Ni as a key indicator for the structure of this nucleus.
- Compute the structure of neighboring isotopes ^{79,80}Ni to lay the ground work for understanding many more short-lived nuclei beyond ^{78}Ni.

Impact

- Doubly magic nuclei such as ^{78}Ni have a simple structure and are the cornerstones for entire regions of the nuclear chart.
- Our results confirm that ^{78}Ni is doubly magic, and the predicted low-lying states of ^{79,80}Ni open the way for shell-model studies of many more rare isotopes.
- Separation energies enter models of nucleosynthesis.



Accomplishments

- Prediction that the energy of the 2_1^+ state in neutron-rich ^{78}Ni is significantly higher than for neighboring nuclei.
- Finding that ^{78}Ni with charge Z=28 and neutron number N=50 is a doubly magic nucleus.
- Understood the structure of neighboring nuclei opens the way to compute many more isotopes beyond ^{78}Ni.

Caption: Energy of the 2_1^+ state in neutron-rich nickel isotopes for $^{68\text{-}76}$Ni from measured data (black bars) and for ^{78,80}Ni from first-principles computations (red bars) based on the state-of-the-art nuclear forces. The red shaded area for ^{78}Ni shows the predicted range for the 2_1^+ using a family of nuclear forces. The doubly magic nuclei ^{68,78}Ni are strongly bound and not easy to deform, while ^{70,72,74,76,80}Ni are soft with respect to deformation.

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Reference: G. Hagen *et al.*, Phys. Rev. Lett. 117, 172501 (2016)

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